perhaps unfortunate but not essential to decide the question at issue.

Affirmative, 13; negative, 0; not voting, 2.

C. W. STILES,
Secretary of Commission

THE MEXICAN COTTON BOLL WEEVIL

PROBABLY the control of no insect pest has involved greater difficulties than that of the cotton boll weevil. This enemy of a great staple crop works in such a manner that it has seemed beyond the usual means that have been followed in insect control. In all except the adult stage it is found within the fruit of the cotton plant. For the greater portion of its existence, therefore, it is at least as well protected as it would be if it occurred some distance below the surface of the soil. Even in the adult stage the insect has habits that tend to place it beyond the reach of man. As a consequence, investigations of the insect that have been carried on for several years have not revealed a great number of direct remedial measures. In fact, the destruction by burning of the left-over portion of the crop and the insects contained is the only direct means of importance that has been devised. It is gratifying to note that recent investigations by Mr. Wilmon Newell and Mr. G. D. Smith, of the Louisiana State Crop Pest Commission, published in Circular 33 of that commission, reveal another direct means of control that gives promise of general applicability. The work of Messrs. Newell and Smith is of considerable general interest, because it shows a successful outcome from continued investigation leading from a suggestion revealed in research. The investigators observed a clue pointing toward the possibility of control and directed all their energies toward the practical perfection of the idea.

For some years a cotton planter of considerable prominence has been advocating vigorously the use of paris green for the control of the boll weevil. Though well-meant, his campaign has been based upon a demonstrated fallacy. Extensive tests that have been made by various agencies have shown that the application of this poison is by no means a practical means of destroying the boll weevil. One of the agencies that tested the use of paris green was the Louisiana State Crop Pest Commission, of which Mr. Newell is the executive head. Although large and repeated applications did not result in increasing the yield of cotton in the experimental fields, it was evident, both in these tests and in cage experiments, that a number of weevils were killed. Instead of stopping at this point, Mr. Newell conceived the idea of determining wherein the paris green was ineffective and how its action might be increased. There were two important difficulties to overcome. In the first place, as paris green is now manufactured, a small portion of free arsenic causes burning of the foliage of plants. As the amount of the poison applied is increased, this damage, though insidious and at first scarcely noticed, becomes greater until it is very serious. On this account increasing the amount of paris green in the first experiments offered no hope as a practical remedy. The second obstacle encountered was the difficulty of forcing the poison into the portions of the plants where a considerable number of weevils would be likely to obtain it. The mechanical structure of the poisons in use prevented this. They were too coarse for effective work. To obviate the first difficulty, Mr. Newell determined to use arsenate of lead, which can be applied in very large amounts without any injury whatever to the foliage. The second difficulty was overcome by inducing a manufacturer to put up a special, finely powdered form of the poison. When this point was reached, a considerable series of field experiments was outlined. These experiments comprised about forty-six acres of cotton to which the poison was applied, as well as forty-nine acres provided as control areas. The treated cotton in these experiments produced an average of 71 per cent. more than similar cotton in the checks. In some cases the net profit was even startling. In one case a net profit of over $23 per acre was obtained.

A large portion of the effectiveness of the application of powdered arsenate of lead in the experiments was undoubtedly due to the thoroughness with which the work was done.

A special device, involving an air blast, was used to force the poison into the parts of the plant most frequented by the adult weevils. In the experiments described the application was made in person by the junior author, Mr. Smith, or under his personal supervision. It is possible, and in fact is forcefully pointed out in the report, that such successful results as those obtained in some of the experimental work should not be expected under the practical conditions on plantations. The writers even point out that it is likely that nine out of ten planters will fail to obtain satisfactory results from the first work they do. Nevertheless, every consideration seems to indicate clearly that powdered arsenate of lead can be used very profitably as an important adjunct in connection with the system of control that has been in use heretofore.

It is not extreme to state that the work accomplished with powdered arsenate of lead by Messrs. Newell and Smith marks an important advance in our knowledge of the control of the boll weevil. It promises in a short time more than to compensate the state of Louisiana for all the money that has been expended in the operations of the Crop Pest Commission since its establishment.

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SPECIAL ARTICLES

DOUBLE IMAGES OF AN OBJECT AS SEEN THROUGH A WATER SURFACE

In Science of November 29, 1901, the present writer discussed this subject as presented by Matthiessen.[1] It was there pointed out that Matthiessen's equations had all been deduced in a paper by the present writer, in 1881, in the *Transactions of the Academy of Science of St. Louis.*

Matthiessen urged that two images of an object are formed when it is viewed through a water surface. One lies upon the caustic of refraction, and is therefore above the level of the object, and nearer to the eye. The other is along the same line of sight, but on the normal through the object.

[1] *Ann. der Physik*, 1901, No. 10, S. 347.

In my paper of 1881 the latter image was discussed as the one actually seen.

It is evident that all rays from a point on an object thus viewed, will when produced backwards, not only be tangent to the caustic but will also cut the normal. Every ray of the cone of rays whose base is the pupil of the eye will thus appear to pass through an area on the surface generated by revolving the caustic around the normal. They will also intersect between two limiting points on the normal. The image of the point will therefore appear as distorted into an area on the caustic surface, and as a short line on the normal. My idea has always been that the former image was too indistinct to be visible.

Recently, while deducing the equation of the caustic, it occurred to me that the image might be seen upon the caustic surface, if the head were inclined so that the eyes were in the same vertical plane. The axes of the two cones of rays make then with each other an angle lying in the vertical plane, and the eyes may be focused on their point of intersection. The images on the caustic will then be practically superposed, and the line images on the normal will be more widely displaced on each other. The experimental result is very striking, and may easily be obtained by observing a chain, or the water-plug and chain at one end of a bath tub filled with water.

When both eyes are used, the water plug with the vertical chain, to which it is attached, appears projected towards the observer by a foot or more, if the eyes are near the surface and at the opposite end of the bath tub. If one eye be now closed, the image recedes to the vertical line through the object, appearing along the same line of sight as before. It therefore appears at a lower level.

When both eyes are in the same horizontal plane, the image is seen on the normal through the object. The images on the caustic surface as seen by the two eyes are then displaced on each other, and those on the normal coincide. Opening and closing one eye then produces no change in the position of the image.

Francis E. Nipher